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TABLE OF CONTENTS

Placement Tests as a Means of Predicting Failures in First Year Work in Engineering, University of Washington. E. R. Wilcox 791
Report of the Conference on Civil Engineering 795
Report of the Conference on Industrial Engineering and Shop Practice 820
Division of Cooperative Engineering Education 841
New Members 841
American Engineering Council 843
Present Trends in Medical Education 843
Greeting to A. S. M. E. 844
College Notes:
Massachusetts Institute of Technology 845
Book Review 846

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PLACEMENT TESTS AS A MEANS OF PREDICTING FAILURES IN FIRST YEAR WORK IN ENGINEERING AT THE UNIVERSITY OF WASHINGTON

By E. R. WILCOX

University of Washington

Beginning in 1924 with the creation of a separate department for all freshmen engineers, placement tests in high school subjects were introduced as a means of preliminary classification of entering students. On the basis of this classification, students were placed in fast, average, and slow sections. This preliminary classification has never worked out perfectly but readjustments are made from time to time as found desirable. As a whole the system is working with satisfaction both to the students and to the department.

The Iowa Placement Tests in mathematics aptitude and training are now used for mathematics classes; physics aptitude and training tests for engineering problems classes, and a drawing aptitude test which has been developed by Professor Warner and Mr. Jacobsen of our department is used for engineering drawing classes. A record is kept on the student's personnel card of the percentile score made in each of these five tests together with the percentile score on the University of Washington College Aptitude Test, for each engineering freshman. These tests are given during the first regular class period in the respective subjects except the college aptitude test which is given to all university freshmen during freshmen week.

In the past, it has been found that the placement test scores are reasonably indicative of the man's final grades in his subjects. The rather obvious idea suggested itself this year that a study of the cases of men with low scores in two or more placement tests might reveal information that would be useful

in detecting early in the quarter probable maladjustment and consequent trouble later on. An entirely arbitrary division was made to include all men who placed themselves in the lowest twenty-five per cent in two or more of the six tests given them. Due to entrance deficiencies and other irregularities not all the freshmen engineers took all six tests but no one is included in the 300 cases studied who received scores in less than two tests or who received final quarter grades in less than two first quarter subjects.

Our grading system consists of five steps, A, B, C, D, and E, the last two being unsatisfactory. The scholarship rules are such that a grade of E in more than one-third of a student's hours in any one quarter causes him to be dropped from school, and a lower division student accumulating a total of more than one third of his hours of D grade for any two quarters also is dropped. A student who acquires more than one third of his hours of a D grade for any one quarter is warned that he is in danger of being dropped the following quarter if his work does not improve.

At the end of the fall quarter, the grades of 300 first quarter students were studied. 79 of these students had placed themselves in the lowest twenty-five per cent in two or more placement tests. 49, or 62 per cent of these 79 men, appeared on the warned and dropped list, while only 23, or 10.4 per cent of the remaining 221 students appeared on this list. The total of 72 men on the warned and dropped list is 24 per cent of the total of 300 cases. The 79 low percentile placement test men, or 26.3 per cent of the entire group thus furnished 68 per cent of the low scholarship cases. To put it another way, the men who placed themselves in the lowest quartile in two or more tests had nearly two chances in three to be in the low scholarship group at the end of the first quarter, while those not in this low placement test group had only one chance in ten to be in the low scholarship group.

A further study of the grades of these 79 men at the end of the winter quarter showed that a total of 60 of these men or 76 per cent had appeared on the warned or dropped list by the end of the first two quarters. In other words, slightly less

than one fourth of these low placement test men had been able to carry satisfactory two quarters of engineering work. The grades of some of these men were barely satisfactory.

Another grouping of 24 students who ranked in the lowest fifteen per cent in three or more placement tests was studied. At the end of the fall quarter, 19 of these men, or 79.2 per cent of the group appeared on the warned or dropped list. From the foregoing, it appears that by the end of the second week of the first quarter, a group of freshmen could be assembled who need very special consideration in the way of reduced schedules and special reviews or who definitely should be discouraged from continuing the engineering courses. There are, however, a very few who will eventually do well and who should not be discouraged. Possibly some time should be wasted on the many for the sake of these few.

As a check upon the validity of measuring a man's scholastic failure by his poor grades in only one third of his hours, the grade point average for each of the 300 men was computed. This was done by assigning values to the grades as follows: A = 4, B = 3, C = 2, D = 1, and E = 0. These number equivalents were then multiplied by the number of credits obtained of a given grade, the weighted totals added and the sum divided by the total credits received for the quarter thus giving a grade point average for each man. The distribution of the grade point averages for the first quarter for three groups is shown in table No. 1. Comment upon this data seems unnecessary.

While the foregoing all sounds very interesting, the question yet remains of what to do about it. We are making definite plans this fall to get the group of men together early in the quarter who have made low grades in two or more placement tests. We shall give them the results of our previous study and explain to them frankly their possibilities and probability of failure. We then intend to give each man in the group careful study in regard to his present program, his previous preparation and any desirable readjustments which can be made. If some men can be discouraged from taking engineering by this means, that will be quite satisfac-

tory; if others can be salvaged without having to pass through the elimination machine, that will be well. We do hope to get a much better adjustment between the student and his educational environment earlier in his career than has been previously possible. We are also hoping to eliminate from the engineering college many of the students who become the barely passing men in the upper division work and who are unable to find and hold satisfactory positions upon graduation.

COMPARATIVE DATA ON PLACEMENT TEST RANKING AND FIRST QUARTER GRADE POINT AVERAGES

No. 1. Distribution of Grades of Men Who Were in the Lower 25 per cent in Two or More Placement Tests—Fall Quarter 1928

Grade Ave..... Point Ave.....	0–0.49	D− to D+ 0.5–1.49	C− to C+ 1.5–1.99	C to C+ 2–2.49	B− to B+ 2.5–3.49	A− to A+ 3.5–4
No. Students...	8	28	20	18	5	
% of Group....	10.1	35.5	25.3	22.8	6.3	

Total Number of Students = 79

No. 2.—Distribution of Grades of Men Who Were in the Lower 25 per cent in Only One Placement Test—Fall Quarter 1928

Grade Ave..... Point Ave.....	0–0.49	D− to D+ 0.5–1.49	C− to C+ 1.5–2.49	B− to B+ 2.5–3.49	A− to A+ 3.5–4
No. Students.....	4	11	32	9	4
% of Group.....	6.7	18.3	53.4	15.0	6.7

Total Number of Students = 60

No. 3. Distribution of Grades of Men Who Were Not in the Lower 25 per cent in Any Placement Test—Fall Quarter 1928

Grade Ave..... Point Ave.....	0–0.49	D− to D+ 0.5–1.49	C− to C+ 1.5–2.49	B− to B+ 2.5–3.49	A− to A+ 3.5–4
No. Students.....	2	11	66	60	22
% of Group.....	1.2	6.8	41	37.2	13.7

Total Number of Students = 161

REPORT OF THE CONFERENCE ON CIVIL ENGINEERING *

A. H. FULLER, *Chairman*

The word "coordination" was used deliberately in the subject for this conference rather than relation or some similar term. A profitable meeting might result if all of the effort were directed in determining the existing conditions. Much of the meeting will doubtless be devoted to that end. More than that, however, is implied as the subject for the conference. Determining the conditions is collecting the facts. Making the best use of the facts is the ultimate goal. True coordination is a necessary step in making the best use of the facts.

We all know fairly well the details of the training of our college graduates. We also know about what is expected of them in the various lines of work in which they find themselves. But have we analyzed the training in college and the subsequent experience with that care which is necessary to insure a high economic transition from one to the other? Are the College Faculties sufficiently alert and sufficiently broad to modify their pet ideas to meet the changing requirements of practice? Are the employers of college graduates sufficiently alert and sufficiently broad to modify some of their pet ideas in regard to what a raw graduate should do during the first year and during the later years? Do the "pet ideas" of the professors and of the captains of industry differ, primarily, in principle or in detail? Is it possible to reduce the differences so that a better understanding may be had and a better correlation be made than even the good understanding and the good correlation that now exist?

For the discussion of these questions, a couple of hours have been set aside this morning. We will not answer all of

* This conference was held in connection with the 37th annual meeting of the S. P. E. E., at Columbus, Ohio, June 20, 1929.

them to the satisfaction of everyone. It does not seem too much to expect, however, that substantial progress may be made. At least those of us who are here should go home with that better understanding of the other fellow's viewpoint which will insure a better understanding and a more intelligent interpretation of our local conditions. If, at the same time, we have the foresight and the courage to reflect the spirit and the results of this short conference in making, revising and administering our curricula, the conference will have been justified.

FRANK T. SHEETS, *Chief Highway Engineer of Illinois*

A discussion of a coordination of the civil engineering curriculum and the work of the civil engineer after graduation by one not engaged in educational work and who is unskilled and untrained in the science of education, can be of value only insofar as the writer refuses to be up-stage, divulges the shortcomings he finds in himself and those around him, bemoans the things he himself missed in his college course, indulges his own particular brand of heresy about the subject of engineering training, and presumes to set himself up as an expert on a subject he must by force of circumstances know very little about.

With this confession of ignorance and without having read what has been previously written on the subject, I am going to throw discretion, modesty, and technical style to the winds and say frankly some things I have had on my mind for a long time. If what I say has merit and is helpful, I will be pleased; if it is valueless, no harm has been done except possibly to myself.

After fifteen years' association with civil engineers since graduation from college, the last eight of which were during my tenure of office as the engineering head of a large public works organization employing several hundred engineering graduates, I am convinced that the most important thing to teach an engineer is how to think. I am not particularly concerned about what an engineer has studied in college,

but I am concerned in knowing whether he has learned how to study, how to think originally, and how to say what he thinks in plain, simple, comprehensible oral or written language.

There are entirely too many engineers who fail in these respects, and who are entirely at a loss when problems and circumstances not described in the textbooks or classrooms arise, and further, who rely on the elementary mode of expression of their grammar school days to convey their thoughts about technical problems or business affairs.

How my heart warms within me when I find in my organization a man who refuses to be stumped when he finds a problem not covered by the rules and not encountered in his previous experience; who does not have to be led every step of the way; who thinks out the answer to a problem and offers its solution, instead of waiting passively to be fed with a spoon by the boss; who knows how to marshal facts in a logical, orderly and understandable manner; and who can compose a report or letter which does not outrage one's conception of English, and to which a superior officer is not ashamed to affix his name.

Busy executives are crying for men who can think logically and originally, and who can express their thoughts in clear, crisp and pleasing language. They want men who can prepare reports and letters which can be checked and approved quickly, and for which they can safely assume responsibility so far as the world is concerned by affixing their name. Yet engineers who can do such work are hard to find. They can name their own price. In spite of this, I venture to say that in the engineering schools of today there is as large a percentage as there was fifteen years ago who either rebel or scoff at the very courses which would tend to develop their latent talents along lines that are most in demand.

To summarize these thoughts, I firmly believe that technical courses should be designed so that they will make very difficult the graduation of students who have not learned to think originally, to marshal facts in a logical and orderly

manner, and to speak publicly and to write in an understandable, pleasing, convincing and correct manner. To accomplish this, I would make class work in any subject demand of the student new and original thought and frequent spoken and written discourse, and I would grade a student in proportion to his development in these respects.

If I were an educator, I would have much more pride in developing ten high-grade men possessed of these essential characteristics than in turning out at the end of four years a hundred more or less skilled artisans, many of whom will never attain the accomplishments which should attend the title "Engineer," due alone to the lack of certain essential training.

To accomplish these things, rare discretion must be used in choosing the faculty. Just any one who happens to have a B.S. or M.S. degree won't qualify. Teachers must know how to teach. If they do not know the fundamentals of teaching, they should not be turned loose upon the unsuspecting freshman who comes burning with enthusiastic ambition to revolutionize the engineering world. The teacher must have the broad human sympathy, the personality and the proper highminded purpose to win the confidence and respect of his students, and the ability to excite the interest and enthusiasm of the embryo engineer—in other words educational salesmanship—or else the student will not get what he is paying for.

The most able research specialist may possibly make a horrible mess of teaching, and the best teacher may not be by temperament especially gifted in research work; but, on the other hand, he may be able to interpret the findings of the research department to his students so that they take on the interest of a fairy tale. With this fact in mind, I would organize an engineering faculty so as to assign to teaching gifted teachers, and I would not spoil a good research man by making him try to teach, if he had no talent along that line. I would keep in mind that a good teacher should not be forced to neglect his teaching to test beams, nor to write

a book to advance his standing. But I would see to it that every teacher kept abreast of the times in the subjects assigned to him. If I happened to find a man who was both a good research specialist and a warm, sympathetic, inspiring teacher, I would know I had found a pearl of great price and would be governed accordingly in fixing his compensation.

In addition to these general topics regarding engineering education, there are certain specific details concerning which I have definite views.

The average freshman who proposes to study civil engineering or any of its specialized branches, such as highway engineering, comes to college rather firmly imbued with certain romantic notions about engineers he has seen using surveying instruments in the field, and itching for the opportunity to peak through a transit or level and write figures in a book.

Why do we stifle this enthusiasm by postponing his introduction to the fundamentals of surveying which could be taught to a first-year high school student in some measure, and substitute therefore abstract mathematical courses? Would it not be better to let the freshman engineer's study of algebra and trigonometry go hand in hand with his course in surveying? He would then see the practical application of his mathematics courses and would take more interest in those subjects. Further, his urge to learn what he considers the essential thing in engineering, namely, the use of engineers' instruments would be satisfied, and he would then be able to assimilate with a clearer perspective the more cultural and advanced subjects which are necessary to round out the education of an engineer.

Likewise, in the sophomore year, why should not certain fundamentals of the mechanics of materials be taught along with purely mathematical courses, so that the engineering student would not be forced to wait until he is a junior before he learns how to design a simple beam?

In my opinion, if certain of these comparatively simple yet fundamental parts of an engineer's training could be given

to the students earlier in their engineering courses, better cooperation would be secured in the broader and more advanced courses.

Frequently I think that in arranging our college curriculums, we have placed the cart before the horse and have endeavored to give the engineering student the broader, cultural side of his education at the beginning of his course rather than throughout it or toward its close. The practicing engineer goes through a number of years of work in which he uses quite largely the mechanical and purely technical side of his training, and, with the coming of experience, he takes on executive duties which involve not only the purely technical but also the business, economic and public relations side of engineering work. In the same manner it seems to me the student should be given enough real engineering training in his freshmen and sophomore years to satisfy his natural appetite for such work, and when this has been done, he should be made to see the importance of assimilating certain broader yet equally important courses which will in the final analysis be invaluable to him in proportion as he attains experience and executive duties during his professional career.

In this connection, I believe that all engineers should receive a sufficient training in the fundamentals of economics, business law, and accounting to be able to talk the language of the specialist in these lines and to understand the significance of problems relating to these subjects. A course in economics could be modeled so as to stimulate the interest of the engineer in the relation between engineering structures and engineering works and the economics of their financing and operation. Certainly an engineer is playing a minor part in the picture if he does not understand and interpret to himself, his employer, or his client the broad economic principles which are related to the engineering structure or work on which he may be engaged.

If he gets beyond the purely technical side of his work and begins to deal with executive and administrative prob-

lems, he must of necessity understand certain fundamentals of business and contract law, and further, he must have sufficient knowledge of the principles of accounting to understand accountants' reports, to direct accountants' activities, and to make accounting systems as ready a tool as his slide rule, his knowledge of surveying, calculus, mechanics, or any other more technical side of his training. Too many of our engineering graduates have not the faintest conception of double entry bookkeeping, the interpretation of a trial balance, and many wouldn't know a serial bond if they saw one.

It seems to me that if the engineer is to rise above the class of a mere hireling, he should be trained in the fundamental principles of financing public and private improvements, and the engineers who have gone out from college and have attained success in a larger way have all been forced to acquire their knowledge of these general subjects in the "hit or miss" fashion which generally accompanies the explorations of an individual into the study of unknown subjects; whereas, they would have been much better equipped had the general outline of these subjects been presented to them in a well coordinated college course.

Again, I have noticed a crass ignorance on the part of the average engineer about geology or the study of the very earth upon which all of his engineering work must be built. We have run into problems repeatedly where mistakes have been made which could and would have been avoided had the engineer in charge had sufficient knowledge of the fundamental principles of geology to have interpreted the conditions at hand. In fact, some of the recent failures of rather monumental structures may be traced to a lack of proper understanding and interpretation of geological conditions. Therefore, I would give an engineering student a thorough training in geology, with a special view to developing in him the ability to interpret the significance of geological formations and conditions in their relation to the building of engineering structures and works. Although we cannot hope to make an expert geologist out of an engineer in the lim-

ited time that can be devoted to this subject in an engineering course, we can most assuredly educate him to understand the importance of this subject in its relation to engineering work, so that in cases where there is any doubt about the solution of such problems, he will at least know enough to call in an expert to consult with him. By doing so, he may avoid a disastrous failure of his engineering undertaking, as well as the prevention of great loss to his clients.

I would also give to the highway engineer especially, sufficient training in chemistry to enable him to understand the properties of asphalts, cements, paints, and other engineering materials. In doing this, I would not crowd him into a miscellaneous class of students studying household science, agriculture, and literature and art, nor attempt to appall him with the atmosphere of a class of students majoring in chemistry, but I would develop for him specialized courses which would arouse his interest in the subject of chemistry by showing him its relation to his engineering work. Rather than asking him to read page after page out of a chemistry book and to memorize chemical formulæ which he cannot reason out, I would give him sufficient understanding of the general principles of chemistry to enable him to intepret chemical problems in their relation to his work and then to know when and how to get proper expert advice on chemical subjects. Likewise, I would give him similar training in the closely related subjects of water analysis and sewage disposal.

I could continue to enumerate other subjects which might well be stressed in an engineering course, but the preceding discussions cover those which I wish to emphasize. In this connection, I do not wish to imply in any way that fundamental technical subjects should not be given a prominent place in an engineering course, but I think that some of these subjects could well be substituted for some of the socalled practical courses dealing with specialized applications of fundamental engineering principles, and also for some of the socalled shop and laboratory courses which are frequently overdone.

To my mind, it is more important for an engineer to know how to go about the financing, design and operation of an engineering work than it is for him to know how to make a wood pattern or to hammer out a cold chisel. He can hire skilled artisans to do this a lot better than he can ever hope to do it; the essential thing for him to know is what the shops can do rather than how to do it himself.

In conclusion, I wish to emphasize again the importance of teaching engineers how to use English. I would include in every engineering course a thorough training in rhetoric, English literature, and public speaking. Without these, the wisest technician may appear exceedingly simple. They are tools which the engineer cannot be without. The dignity of our profession demands that engineering graduates employ oral and written English commensurate at least with that employed by other professional men.

J. M. FITZGERALD, *Assistant to Chairman*, Committee on Public Relations of the Eastern Railroads, New York City

There has never been a time in the history of railroads when they have been entirely in the hands of engineers; there has not been a period when the roads could do without engineers; and engineers are, perhaps, of more importance in railway operation today than ever before.

For nearly a century we thought of rail transport almost entirely as an agency through which we could exchange and distribute our products. Speed was not the essential factor during this period of our transportation history.

But the World War left us with an entirely new set of transportation economics. Costs of labor and material have increased enormously. The place value of our goods and products naturally advanced to a much higher basis, and speed became the essential factor in transportation. As the value of goods in the hands of railroads at all times is estimated to exceed one billion dollars, you can readily appreciate the value of speed in financing the distribution of goods in this country.

When the roads emerged from governmental war-time operation in 1920, their owners and managers not only faced the job of moving the traffic of the country, but they met a demand that it be moved at the highest possible speed, consistent with safety; and on dependable schedules.

During the past nine years engineers have practically recreated a railroad system which it required ninety years to develop; and during that same nine-year period rail operations have been marked by an ever increasing efficiency, continued reductions in operating costs and a steady decline in freight rates.

Railroads passed the experimental state many years ago, and they have also emerged from the development stage. They have entered a period of intensified use, and future expansion will be secured largely through a greater use of existing rail facilities rather than by construction of new railroad mileage.

The development of the early railroads rested largely upon the civil engineer, but all branches of the engineering profession are today being utilized in an effort to produce the most efficient, the most dependable and the fastest transport service, at the lowest permissible cost. In other words, railway operation today is a battle of engineering science directed to still greater efficiency of traffic movement and still lower costs of producing service. Therefore, the importance of the engineer in railway operation is not likely to contract—it is more likely to expand.

The opportunity of the graduate engineer to enter railroad service has been the subject of much discussion, particularly during the recent years.

The statement is frequently made that the wage offered by railways is low when compared with that of other industries; that promotion is slow, and that railways are not as anxious to secure young engineers as are other industries. As it is sometimes said that young engineers have a feeling that there is very little opportunity for them in the railroad industry, it might be well to review briefly the situation.

It is almost impossible to compare the railroad situation with any other business as there is no other industry whose operations are restricted by governmental regulation to the same degree as American railroads. Various phases of regulation cover, perhaps, seventy-five per cent of railway operations.

Moreover, railways are regulated by different governmental agencies. One branch of government endeavors to establish the highest possible value for railway property as a basis for railroad taxes; and another set of officers is trying to prove that the same property has little value in a rate proceeding. In other words, the efforts of both sets of officials tend to prevent the carriers from earning a fair return on either the highest or the lowest value claimed by any public authority.

Railway income is controlled by government through the regulation of rates which they are permitted to charge for service. Therefore, they are not permitted the large earnings which may be enjoyed by other industry. Railroading constitutes a continuous battle—a battle to earn money and a battle to retain sufficient of those earnings to maintain the railway credit necessary to the continuance of efficient transport service.

Therefore, railway operations must be conducted accordingly; expenditures are necessarily measured by the same yardstick which is used to determine earning power. If it be true that salaries to beginners are low when compared with other industry, the same situation may possibly exist with regard to the entire official family.

I have heard citizens glorify the achievement of executives of other industry and insist that large salaries which they were supposed to receive were not enough; but those same citizens would likely be very much disturbed if they thought that they were paying freight rates and passenger fares to provide a similar salary for a railroad executive.

Government regulation of railroad income has made it necessary for railway management to make the dollar go

further—much further, perhaps, than is necessary in other industry. A restricted income has also played a large part in making the railroad industry a highly specialized field of endeavor.

When the government turned the roads back to their owners in 1920, there were about 2,000,000 employees on the payroll. During the past nine years freight traffic has increased about five per cent, and speed of freight between terminals has increased about nineteen per cent; but we now have less than 1,700,000 employees on the payroll.

Of this number, executives, general officials and assistants approximate about 7,700; division officials, assistants and staff assistants, 9,300; or a total executive, general and divisional supervision of about 17,000.

We now reach the field where men are being trained for these official positions. Railroads employ 12,000 engineering assistants of all classes; 5,000 chief clerks and assistants; 4,800 general foremen in maintenance; 5,200 train dispatchers, 6,600 yardmasters and assistants—a total of about 33,600.

Of course, it may be assumed that all of these men are not qualified for official positions. However, the field does constitute a training ground; it indicates why promotion might be regarded as slow by the man who was not up and doing—by the man who was not determined to rise.

The type of men who constitute this training group may be illustrated by a study of personnel conducted by one of the large lines a couple of years ago. The entire operating department was covered with the exception of the engineering staff. Out of more than 25,000 employees, 704 were found to have two years or more of college education; 357 had attended business college; 57 had received instruction through correspondence schools; and 4,016 had attended high school; a total of 5,134.

This study gives us some idea of the situation. You can visualize the opportunity, the available supply, and the character of the men who constitute the railroad family. That competition is very keen is apparent—whether or not a man possesses an engineering degree.

It is also true that many men become railroad minded in their early youth. Figuratively speaking, they are born with a locomotive in one hand and a lantern in the other. They adopt railroading as a profession—determined to rise with or without education; and the history of our railroads is sprinkled with stories of men who have achieved their desire in spite of all obstacles.

It is doubtless true that the roads do not use the same method in recruiting young men for railway service. On some lines a technical education is a requisite for operating officers. On other lines a technical education is not required. Many roads seek engineers from the colleges located adjacent to their line; some go beyond their own rails; and others depend on voluntary applications which they receive.

We must recognize that there is no royal road to a successful railroad career. If and when a man rises, his advancement will be based on achievement—and that only. It will not matter much who he is, or where he comes from, or where he received a degree—what he actually does will be the determining factor. Nor is railroading the place to look for a so-called "easy snap." Railroading is hard work and one must expect to meet some hard knocks.

Regardless of what your young engineers may think, it is nevertheless true that railroad managers keep a very keen eye on what they regard as "young hopefuls" and this applies in particular to young engineers. Those who have spent a lifetime in railroad service have seen too many young men emerge from what they regarded as obscurity, and proceed on their way up the line—propelled by nothing but accomplishment.

Young men should be impressed with the fact that to be successful in railroading a man requires something more than an engineering education. The fact that he is an engineer, or even an exceptional engineer, does not necessarily qualify him for a managerial or executive position.

Educational institutions produce engineers, but I have never heard a college claim that it turned out a finished

operating railroad man; and some of these young men fall by the wayside because they fail to realize that having qualified as an engineer, they must also learn railroading if they are to be successful in that field.

Young engineers who desire to enter the railroad industry should have vision and initiative. They should be resourceful, possess personality, have the ability to handle men, and be able to sell themselves to the management. A man who cannot sell himself to his superior officer will not be able to sell himself to the men under his direction, nor will he be able to sell his railroad to the public. If and when a man reaches official position, he must be equipped to meet men who spend much time in the discussion of policies and who devote little time to engineering details.

There is little need to worry about the future of railroads. They are not leaving us. They will not be replaced by the motor car, the airship, artificial waterways or canalized rivers. They will continue as the great producers of mass transportation.

Railroading is not a job. It is not a business. It is not something to be taken up today and laid aside next week. It is a profession, a life work in a highly specialized and dynamic industry, which is full of romance. It is not a place where a man can expect to get rich quick or secure a large salary in a hurry. But railroading does offer great opportunities to young men who possess the proper qualifications—provided they know how to use those qualifications.

Discussion

George T. Seabury, Secretary American Society Civil Engineers: I wonder how many of you have seen in the American Legion monthly a little story about the negro who had not only been taken in but had confessed to stealing some chickens. He was sentenced. The judge was quite interested in the problem. He looked down at him and said, "I wish you would tell me how you got those chickens. The owner was asleep on the ground floor in the back room right next

to the yard where the chickens were kept, and there was a fierce dog in the yard. I just wish you would tell me how you did it."

The negro looked at the judge and said, "It wouldn't do you no good at all if I was to tell you. Like as not you would get your skin full of shot and you wouldn't get the chickens at all. Jes' stick to the bench where you are familiar if you want to indulge in any rascality."

I do not know your topic anywhere near as well as you do, so why should I talk about it? However, you have started me on two or three things which I have thought of before and to which I haven't a definite answer. Nevertheless, they are things that are worth thinking about.

Your speakers of this morning were commercial men. In other words, you go to a type which you visualize as the existing type within the country today.

I see a tremendous competition going on in the world, not particularly in this country only, but between this country and other countries, between corporations within this country. It is my hunch that within a few years we are all going to be hired men. We may not like to work, but we are going to, in organizations. I think the entire industrial system is organization in type. We will not be found at any one particular level in that organization. We will go as far as we develop ourselves. We will then be leaders of groups and some of those groups will be near the bottom and we will be with them; some of them will be near the top in this sort of pyramidic structure and we engineers may be the very top of the structure. I think we will be at the top of each of our several units within that structure.

We have to compete in that thing. I am not now speaking as to how you are going to compete with me, but all of our type are going to compete with the fellows of the other types, the fellows who are otherwise equipped.

To make my point particularly obvious, let us say the high pressure salesman hasn't the equipment that we have and yet he is in competition with us. If we are going to take

high places we have to watch his movements and be guided accordingly.

I cannot speak directly to the point of your topic today, that is, the relation of the curriculum to the life of the professional engineer, because I do not know your curriculum. However, this thought is in my head, and I am trying to work it out for myself at least and it is tied up with the general idea because young men are hero worshippers. They may find for themselves some very large and fine hero other than yourselves.

It is quite probable that you, in your four-year contact with them are more or less their heroes. I think that aside from the curriculum you gentlemen have the wonderful opportunity of distilling into them the things which are going to make them successful as in competition with these other men, these high pressure salesmen if you want to call them that, who are in this competitive commercial, industrial field.

So far, the way I have been talking to you has been very much in the same way as the minister talks to his congregation when part of the people are not present. As I say, I think you have the opportunity of doing things aside from your curriculum. I know there is no group of men in the world that has the idealism more than do teachers. Therefore, what I have said must be platitudinous to you, except as you see the application of your already well directed efforts.

As I see it, there must be three first essentials that the engineer ought to have in order to compete with the other group. They are quite practical and quite low to the ground. I think we should inspire, in our younger men, a respect for personal appearance and let us be crudely specific about it. They ought to be taught to have their hair trimmed frequently and to keep their finger nails clean and see that the nicotine stains do not remain on their hands. They ought to have their clothes pressed and their shoes shined. This fellow whom they are in competition with has that as his principle and he makes great use of it. His first presentation,

in his effort to sell himself, is his personal appearance. He tries to sell himself from the moment he enters the door. After that he has to have a second attribute. He has to have poise and meet whatever situation comes up at the moment. He should become master of that situation as it comes up.

To do that he has to have a tremendous amount of experience. He has to start and fail, and try again, and try again until he succeeds. Then I think that he will achieve his highest success if, after he has acquired the art of personal appearance and the art of poise, he acquires the art of being able to speak on his feet and more particularly on subjects other than of his business.

Those are three practical salesmanship ideas which seem to me engineers should acquire if they are going to be in this pyramidal structure in the position of the higher leaders.

T. R. Agg, Iowa State College: I would like to take a moment to call attention to one suggestion that Mr. Sheets made in his paper. If you will recall, he referred to the inadequacy of the type of instruction in chemistry that the Civil Engineer ordinarily receives.

I think there is an opportunity for us to improve our courses of study in that respect. I have an idea that if you check up on the chemistry work that your students are doing at a good many of the institutions you will find the same thing that we find occasionally: That courses are being dry-labbed. When you have that condition it is not healthy. It means that the type of discussion and the character of the subject matter is not of interest to the engineer and he, therefore, takes the shortest possible route in passing up the course.

I believe we ought to consider, very seriously, some revision of the type of instruction in chemistry for Civil Engineers, and particularly if the courses are the equivalent of about five hours throughout the year as is often the case, and we might consider cutting that about in two.

E. F. Chandler, University of North Dakota: This is really not on the topic, but I have noticed for so long the difficulty

in giving them the point of view of actual practice to make them realize the old saying of the truth of it that the successful engineer is the man who can, in construction work or anything else, accomplish for $5 what any other darned fool could finish for $10.

There is just one little point that I have had success on for years in the way of interesting the students and giving them a point of view. We usually use it after the case of sewer design and construction. We pretend they are all contractors and they get a little $100,000 job. The specifications are all drawn up. Each one figures out his unit prices for everything. Then the contract is let.

When the bids are opened they have about two days of discussion among themselves as to why some fellow made such a ridiculous bid. Maybe the fellow who gets the contract, because of being a low bidder, forgot some important item of the contractor's profit.

They begin to realize that all of those items of overhead count, and before they get through they set it in such shape that they can become good material clerks for a contractor. I know that some of them, afterwards, have developed into quite successful contractors. That was the start of it. That is not in the textbooks. It works very nicely in a small institution.

Mr. Agg: The reason they forget the contractor's profit is that all the contractors say the contractor's profit is that mathematical quantity we know as an imaginary quantity.

A. C. Lyon, University of Maine: We emphasize the parts of chemistry, geology and English in our curriculum. We are trying to get all we can get into the curriculum.

I wonder if the men who are not teaching realize how difficult it is to get in all the subjects we wish to get in, together with as many hours as we wish for that particular subject? That is our great difficulty. We are limited to 150 hours for the four years. The great difficulty is to get in as many hours of these important subjects as we wish to get in without cutting out something else which is also important and which does not change the four-year course to a five-year course.

Chairman Fuller: That point will be brought out tomorrow afternoon in another report of this Committee No. 15. We have received, from a large number of engineers, expressions about curricula, by pointing out the fact if anything is added something must be subtracted. We asked them to specify what they want to subtract in order to add something. The results are interesting. The report will be published in the June JOURNAL.

Clement C. Williams, University of Iowa: I was impressed with the general topic of the discussion of this morning, the coordination of Civil Engineering curriculum and the work of the Civil Engineer after graduation.

I am rather skeptical about a very close coordination between those two things. I deprecate any very specific effort to attempt to partake in, with refinement and precision, the work of the Civil Engineer after he leaves college and shaping up the curriculum that he will follow except in so far as the point which Mr. Seabury has so well put before us. I find so few students actually guessing accurately what they will do when they leave college, except in a general way. I find so few faculty men predicting with any great amount of precision what their students will do in detail that I should doubt the wisdom of attempting to predict, with precision and in detail, what the student will do and then try to shape up the program that will follow to prepare him for those particular things.

Some of the things which Mr. Sheets's paper contained bear on this point. I am inclined to think that our first thought should be for each student to think well and express his thoughts clearly. The particular lines that he will follow after he graduates will pretty well take care of themselves, if you will do that.

Perhaps two main objectives should dominate the curriculum, with a view to the student's after-life. One is that he should have a certain criterion of achievement with regard to any project that he undertakes. He ought to have a criterion of what thorough study of the problem is and he can

get such a criterion only by studying rather thoroughly into some particular line of work while he is in college.

The other objective of the curriculum should be making him conversant with the whole range of engineering. I have very little sympathy with the efforts on the part of some of the teachers in our Society who attempt to scatter, generally, the curriculum over a whole field of engineering with the hope that whatever the student may go into after he has graduated he will be prepared to give a good account of himself in that field.

Mr. Sheets used the term "thorough study in geology" or some such phrase as that. A thorough study of geology comes with a Ph.D., perhaps in geology. He said something about a thorough acquaintance with contract law. That could only be obtained after a very long study, or periods of study which are entirely out of proportion to the rest of the curriculum.

I believe that the best we can do in geology and contract law and accounting and economics and a good many other subjects, is to give the student something of the vocabulary involved in those subjects, making him conversant with the subjects to the extent that he can confer with a lawyer intelligently, or he can confer with an accountant intelligently, or with an electrical engineer intelligently if he is a Civil Engineer.

The second objective then that I have for our curriculum is to give the student the vocabulary of the whole field to a certain extent. That objective can be achieved by rather brief courses in a great variety of subjects.

The first objective can be achieved only by a very thoroughgoing study in some particular line which will give him a criterion of thoroughness.

To illustrate the point: I should say that a student might devote all of the 140 or 150 credit hours to a great range of subjects allocated almost uniformly to these subjects in equal amounts, perhaps we will say a 10-hour course in electrical engineering, a 10-hour course in steam engines, and so

on with a view to preparing him broadly for the whole range of engineering. He might take two- or three-hour courses in those subjects and spend so much more time on structural engineering. I should advocate the latter program because if the student spends most of his time in some particular thing, such as structural engineering, he acquires a criterion of thoroughness in one subject. That criterion of thoroughness is applicable to almost anything he takes up. He will have that standard of study and of mastery regardless of whether the thing he may be working on later is structural engineering or something else. He will have established in his mind a degree of thoroughness.

The other objective is that of mere familiarity with the whole range of engineering. I think that is as much as we can do. Sometimes I think we are inclined to use that term, "thorough training in economics" and so on. That is, however, quite impractical.

Ivan C. Crawford, University of Idaho: During the past three or four years I have been particularly interested in attempting to develop a better use of spoken English in our engineering students. I do not believe they are any worse than students in other Colleges of Engineering, and I am sure they are more proficient, relatively, than the students you find in some other divisions of the University.

We have adopted the scheme of having our students go to chapel exercises, listen to the speakers, and then have them give a list of criticisms which they have of the speaker of the previous day.

R. A. Caughey, Iowa State College: I wonder if, after all, we as the engineering teachers are not very largely coordinators? I do not mean the teachers of engineering subjects alone. I mean every teacher who gets the engineering student from the time he is a freshman to the time he is a senior.

I took trigonometry in a section taught by a man who had a degree in Civil Engineering. I had the good fortune to know many other freshmen in that section. We, in that section, got a great deal more out of trigonometry than the men

in other sections did. The instructor made it interesting and vital and showed us how to work out the height of a tower, how to use trigonometry in triangulation, etc.

I wonder if the trouble in coordinating doesn't very often come from the fact that we see through a telescope a fly on a barn door that is a mile away and fail to see the door. We should think of our own subject and also try to show how it coordinates with other things.

When we teach structural design wouldn't it be well to talk about construction once in a while and show how the questions of promotion, design, and construction go together?

H. C. Berry, University of Pennsylvania: I think in view of the cooperation we have had from the corporations who have expressed themselves this morning, I would like to give you a little of my experience in the last year.

We have small classes at the present time. During the Easter vacation, in order to get some touch with the industries and the jobs that are going on in the neighborhood, we divided our junior class into groups of about two. We gave them a letter to the contractors, to plants, to factories and so forth, and we made arrangements with these places for two or three of the boys to go in groups so that there would at least be a pair.

We found that most of those boys were delightfully entertained by the operators in the plants, the men and the management, and these people seemed to feel that it was a sort of honor and recognition to take these boys around. When the boys came back they had a story to tell, either in the group or in the class.

The boys were rather pleased with the reception they got and incidentally there was an indication that the boys had had contacts that they did not appreciate before.

Louis Mitchell, Syracuse University: The subject of English has been referred to a number of times at this meeting and other meetings. The impression is usually given that engineers are classed by themselves with reference to the poor usage of English.

In that connection you might be interested in the experience that we have had at Syracuse. All the seniors in the University are required to take the same examination in English prior to graduation. This examination consists of composition and various questions on rules of grammar and definitions and collateral reading and the like.

The engineering students have never topped the list, but on the other hand they have never been in the poorest group either. They have usually come about midway in the list. The students in the Library School and the Graduate School come first, as a rule, then the engineering students come about midway.

During the past year, for the first time, passing the English examination was made a condition for graduation. I was greatly pleased to find that none of the engineering students was denied graduation on that account, although there were about a dozen from other divisions of the University who were denied graduation.

When the engineering students are compared in this way with the other students at Syracuse they seem to uphold their own in about average fashion.

Mr. Berry: May I add to what I said before? The Eastern New York Section held a meeting this year at Stevens Institute. The President of Stevens brought out the fact that they are starting on a new plan with respect to English. They are employing four instructors who will have assigned to them the four different parts of the incoming freshman class this year. Those instructors will advance with the student throughout the four years, as a kind of tutor. It is a tutorial system, perhaps, in English. I do not know whether that is on record in that way or not but I think the records of the Society should have something with regard to it.

Louis E. Wooten, North Carolina State College: In considering the subject of coordination of graduates it might be of interest to state something regarding a survey that we have made down in our school.

We have made a classification of the graduates for the last 25 years, classifying them according to their position, whether

they are manufacturing or highway or half a dozen other things.

We have found one interesting thing: That just about 85 per cent, or a little more than that, by a fraction, follow engineering, or follow some profession with engineering as a required element.

From that survey we get two practical benefits. We get very much of an idea in determining what should go into the curriculum and what should come out of it. Another thing, we can avoid criticism from representatives of the various industries when they say that the curriculum is all wrong, because we can tell them that from their profession we have only five men out of 100 going into that work, or 10, as the case may be. In this way we are very clearly guided in those two respects.

Anthony Hoadley, Union College: Some of the speakers referred to cooperation within the college, more particularly as regards chemistry from the viewpoint of the Civil Engineer.

I think it would be very valuable indeed and would be somewhat of an experience in teaching hydraulics. I happen to teach hydraulics both to Civil and Electrical engineers. The Electrical engineers have to come over into our department to get that subject. You see that it is set apart for them somewhat. It is taken outside their department, whereas most of their work, except mathematics is in the department in the junior year.

In teaching that subject recently I have had in mind the problems which might arise for the Electrical engineer, that, is, they aren't problems that he can solve simply by using his elementary course in hydraulics which he gets. I take occasion to point out where the elements are used later in solving problems which he might have to use from the Electrical engineer's point of view.

In that way I think the Electrical engineers keep up their interest in the subject much better than they would otherwise. It happens that they use different texts for the two courses and they divide the time a little differently. The

Electrical engineers do not have as much time for it. I really feel that the Electrical and Civil engineers would pass the same examinations because the knowledge of the elements are the same, however, the presentation is just a little different.

Chairman Fuller: I have been very much interested in the discussion and feel very grateful to those who have taken part in it. Dean Williams said he thought the question of coordination was hopeless. On the other hand he touched on a point in his discussion which we particularly wanted to bring out. His point, in spirit if not in words, was that we cannot train for the specific, technical problems that each one of the employers of college men may want to be met. The Committee agrees with him. The men from the industries have pointed out that it was quality they wanted more than specific training. I am reminded of a point that was brought up in the discussion yesterday afternoon. It is that the industries know the work of the colleges well enough and have sufficient confidence in the colleges to believe that, as far as technical attainment is concerned our standards are sufficiently high and, after assuming those standards, there are certain personal qualities to be met such as those which have been brought out this morning. In the correlation we, as college men, certainly should keep that in mind. The industries haven't told us, and we cannot tell ourselves very well, how best to bring out those personal qualities. Further research is needed.

We will all agree that a certain amount of application of principles must be made. A two-part question arises, where is it best to make that emphasis in order to fix the principles and to develop the desirable personal qualities? Many of the discussions this morning have touched effectively upon that question. If we can so arrange things that in the teaching of principles and in the emphasis of principles we can at the same time bring out these personal qualities, then and only then are we approaching the standards which we ought to meet in our teaching. That places a challenge on us to watch personal qualities at the same time that we are watching the technical ones.

REPORT OF CONFERENCE ON INDUSTRIAL ENGINEERING AND SHOP PRACTICE *

C. W. LYTLE, *Chairman of Committee*
L. P. ALFORD, *Presiding*

Subjects:

1. The degree granting department *vs.* the service department for Industrial Engineering.
2. The school shop *vs.* the outside shop for training.

MYRON A. LEE, Cornell University

In his paper on "The Economic Aspects of Engineering Education" Mr. W. E. Wickenden demonstrates the necessity of including courses in Engineering Economy and Administration in the Engineering Curricula. If we are to judge by the experience of graduate engineers the inclusion of such courses is perhaps of prime importance.

This contention is supported by the fact that a majority of successful engineers are engaged in work of an administrative nature, and would have profited by the inclusion of such courses in their college curricula.

Most graduate engineers are of the opinion that these courses should be included in the engineering curriculum.

The question under discussion appears to be not whether such courses are desirable but how they may best be included in the curriculum. Should we, in accomplishing this result, cut so deeply into the established curriculum that we are no longer justified in calling the graduate a mechanical engineer, for instance, but must call him perhaps an industrial engineer.

First, let us consider the possibility of including such courses in the curriclum. It is admitted that the field of engineering subjects has so broadened that there is almost no

* This conference was held in connection with the 37th annual meeting of the S. P. E. E., at Columbus, Ohio., June 19, 1929.

end of material which could be included and it is no easy task to teach a comprehensive technical engineering course in four years. However, we find that few undergraduates know the particular field of engineering activity in which they will engage upon graduation. This being the case it is not only unnecessary but undesirable to include courses which have a special application to only one branch of engineering.

By eliminating such courses and assisted by highly specific entrance requirements it is entirely possible to keep in the curriculum all fundamental technical engineering courses and include in the junior and senior years the more necessary courses in Engineering Economy and Administration.

The same criterion should be enforced in selecting these courses as in selecting the technical engineering courses, namely, they should be fundamental or of broad general application.

A suggested arrangement of courses might be as follows:

In the Junior Year.

Elementary Economics.
Accounting.
Elementary Industrial Engineering or Factory Management.

Senior Year.

Industrial Engineering.
Corporation Finance.
Cost Accounting.
Personnel Relations.

The above courses are all either fundamental, or broad and general in scope and are useful training for any engineer who will eventually attain an executive or administrative position.

Most of the large companies have personnel representatives who have made a study of the requirements of their companies as to college graduates. These representatives seem to feel that a graduate from such a course meets the requirements for positions leading to so-called industrial engineering posts. A survey of the positions for which graduates of re-

cent years have been accepted demonstrates this fact. Positions included are:

Production Engineer.
Plant Management Course.
Factory Planning Dept.
Sales.
Operating.
Industrial Gas Sales and Installation Works Management.
Operations—Management.
Sales Engineering.
Etc.

Positions such as these for which graduates in mechanical engineering have been accepted certainly indicate that employers feel that they wish for industrial engineering positions, men who have had a college course containing the fundamental technical engineering work and not a course from which much of this work has been eliminated, leaving neither a course in mechanical engineering nor a business course.

HUDSON B. HASTINGS, Yale University

It seems to me that the question of whether the Department of Industrial Engineering should serve as a service department or as a degree-granting department depends upon the fundamental idea back of a course of study for so-called industrial engineers. Is it to give some knowledge of the technical phases of management to a student who is trained primarily as a professional engineer, or is it to equip the student for an industrial experience having as its definite goal a position of general executive responsibility, including as a basic part of that equipment the fundamental disciplines and method of approach of engineering?

If the first of these alternatives is chosen, then the Department of Industrial Engineering may properly function as a service department, but if the second is selected then it seems to us clear that both the scope of the course of study, and the approach to the individual subjects of instruction, require

the adoption of the degree-granting type of departmental organization such as we have at Yale.

In our judgment the curriculum for a student in Industrial Engineering should provide a foundation for acquiring practical ability in all of the major phases of industrial operation and management. Therefore, in addition to the engineering courses, this program involves courses in Accounting, Business Law, Corporation Finance, Factory Management both in its technical and personnel aspects, Industrial Physiology, Marketing, Statistics, and last but not least, some broadening courses in English, History, and Government.

When to this list we add the preparatory work in Mathematics, Physics, and Mechanics, there is so little time left for strictly engineering courses that even if all of this is concentrated in one field of engineering, say Mechanical, it would hardly be proper to state that such a student had graduated from the Department of Mechanical Engineering. This term should be applied only to those whose course of training is planned primarily to fit them to become leaders of research and design in Mechanical Engineering.

However, the major reason for our type of organization rests upon the proposition that students of industrial engineering should be given a broad vision of the very complicated problem of successful industrial management, rather than a training as an industrial technician.

Thus, while we seek to inculcate the scientific method of approach, we also wish to develop in the students a sensitiveness to the subtle nature of many of the major problems of management, which are not subject to exact analysis and solution, particularly those involving human relations both within and without industry. The special courses which we have developed in the Functions of Government, Personnel Problems, and Individual Reading, serve as admirable vehicles for developing a speculative attitude and an open mind towards such problems, and we hope will stimulate the students to intelligent observation and continued study after graduation.

This conclusion is strengthened by the fact that, in order to be adapted to his special objective, even the engineering courses for our industrial students are different from those given to the professional engineers. Greater emphasis is placed on fundamental engineering principles, since the students will not be checked up on these in later courses. The refinements of theory and design are omitted and this time is devoted to practice in the application of principles to original problems and an analysis of their economic aspects.

With this conception of the scope and purpose of a course in industrial engineering, it can perhaps be readily appreciated why we feel that students in this field should be registered in a separate department.

Without the cooperation of other departments, there is the obvious danger in a broad curriculum, such as ours, that the individual course will become largely descriptive and lacking in the penetration and discipline which is required of the students majoring in those departments. This situation we have fortunately been able to avoid, and although the courses for the industrial engineers are not as inclusive of detail applications, they require just as high standards of intellectual attainment, and provide as effective training in the fundamental engineering disciplines.

Out of our form of organization there flows a number of advantages. It permits the development of an esprit de corps among those students who are interested in the management side of industry regardless of the field of engineering in which they find their greatest interest.

It simplifies the administration of the curriculum, in that other service departments, such as Economics, do not have to consult with four or five departmental chairmen concerning the requirements and class hours of their courses.

It permits the engineering faculty to specialize on the technical phases of engineering. They are relieved from the burden of trying to keep up to date on both engineering design and the broad field of industrial management.

The greatest advantage of the degree-granting type of or-

ganization, however, is that it insures a course of study which is definitely planned throughout to prepare a man on all sides, including breadth of mind, disciplines, and understanding, for ultimate responsibility as a general executive in an industrial enterprise.

Discussion

John Younger: I differ a little from Professor Hastings when he says he is not sure we are on the right track. We are very confident here; we believe we are on the right track in having the Industrial Engineering Department a degree-granting department. More and more we have the feeling that the fundamentals taught in Industrial Engineering are commensurate with those taught in Mechanical Engineering and Electrical Engineering. Problems in the Industrial Engineering course are just as difficult as in other engineering courses and the student can get just as much out of it from the technical aspect. As to what Professor Lee said about industries looking for engineering graduates: we are much gratified with results in this direction; these industries are expressing their wishes forcibly: they frequently want industrial engineers, not mechanical engineers. Firms asking for industrial engineers include: soap manufacturers, A. & P. stores, Five & Ten Cent stores, as well as engineering industries. As Prof. Hastings has indicated, we are training in fundamentals as well as industrial engineering. For instance students must be engineers first and salesmen afterwards; those opposed to this should take courses in the Commerce College. We feel that it is only right that the department of Industrial Engineering be a degree-granting department and we are confident that we are proceeding on the right track.

Industrial Engineering department can be both a degree-granting department and a service department. Dean Hitchcock's Survey of Engineering is a splendid thing; it is a big factor in aiding the growth of Industrial Engineering at Ohio State University. Here at Ohio State too many, not too few students enroll in Industrial Engineering.

George W. Case: At the University of New Hampshire Industrial Engineering graduates have been receiving offers of between $30 to $50 a month more than the graduates of other departments. Brown & Co., in New Hampshire, manufacturers of wood pulp, take industrial engineers. Their industry depends almost entirely upon the research department. This company takes freshmen at the end of the first year and puts them in the Salvage Department. When a foreman wants a man he sends to the Salvage Department. If the freshman develops properly and the company decides to keep him, he is placed in the Engineering Department which is largely an Industrial Engineering Department, working on job analysis, etc. When a student finishes his work at the University he often is taken back into this company and put on the Supervisory Staff. From now on this company is planning to select the foremen and superintendents out of the Engineering Department.

C. W. Lytle: At New York University students graduated from Industrial Engineering have invariably made good but we have not had a growing number to enter the course. The demand for these men is equal to that for any other department in the school. Perhaps the reason for the small number of entrants is that the high school principals do not understand what the course is and students do not realize the demand for industrial engineers until it is too late for them to take the course. We feel that we must change to a service department; that this is a necessity.

M. A. Lee: Professor Lytle is getting to the phase which is very important. We have not been in the game long enough so that any of us know which would be most advantageous; degree-granting or service department. The vital thing is this: the mechanical engineers and the electrical engineers feel that the things that have counted in their training are fundamental things. The field is so broad that specialization is impractical; try to give engineering fundamentals. When the student gets a job he needs to know the fundamentals of Industrial Engineering as well as in any other kind of engi-

neering. He should know economics, cost accounting, personnel work, etc., along with the regular engineering curriculum.

If we segregate industrial engineering perhaps we are taking a step in the wrong direction either from the standpoint of the students or of the teachers of industrial engineering. Every engineer should take certain industrial engineering subjects. Give them certain subjects because these are good for them; students will not realize this until out on a job. Cornell graduates go in for everything except power engineering. All engineering students should take such subjects as accounting, cost finding, corporation finance, etc. They need not take specialized subjects in industrial engineering. A large majority of our seniors in their senior year have no conception of the kind of work they are going to do when they are graduated.

O. M. Leland: Experience at Minnesota has been somewhat along the line just mentioned by Prof. Younger. For eight years we have been giving an orientation course to the freshmen with the same idea as at Ohio State University. The theory was that most freshmen, including engineers, when they come to college do not know which course they wish to take. In order to give them information along this line we have done this: at the beginning of the year each student puts on a slip of paper the name of the course which he thinks he ought to take. It was impressed upon them that they were not to decide at that time but if their minds were already made up they were to indicate such. In fact the freshmen were not allowed for a certain course; they were all registered in "engineering." What has happened is not a matter of theory but a matter of fact: probably less than 1 per cent of all freshmen make any change in their registration from what was indicated at the beginning of the year to the beginning of the sophomore year when they *must* decide which course they want. All of our effort to give these men a chance to select the course that they want on the basis of information given in the Survey course was of no

avail. Now we allow the freshmen to indicate his course and have since found that less than one man in 100 changes his mind as a result of the orientation course. The number of students entering without having a definite idea of the course they wish is getting smaller and smaller. The student sticks to his first decision. Our orientation course was not abandoned. We still see some virtue in it but we are not giving the course with the idea that it will help determine the students' minds.

Minnesota has no industrial engineering course. We are feeling around for such a curriculum. We do not know what to do: to crowd into our mechanical engineering curriculum more management courses or to start out with a degree granting course in industrial engineering. This seems to be an important factor. The mechanical engineers seem to feel that four years do not give them sufficient time to do the work in mechanical engineering that a mechanical engineering graduate should have. If that is the case something must be crowded out of the regular mechanical engineering course to put in some of these courses included in a regular industrial engineering course: accounting, industrial management, etc.

R. C. Disque: I find that the weakness of the theoretical industrial engineering courses is the fact that the courses violate the fundamental principle of collegiate education. Students should take in college those things which they cannot get out of college. Most subjects ordinarily given in industrial engineering the student can get after he is out of college. There are certain courses that contain material that the student probably will never get unless he gets them in college: theoretical mechanics, mathematics, descriptive geometry, etc. Twenty-four out of twenty-six graduates in industrial engineering at the University of Cincinnati went into work which was absolutely identical with work undertaken by business administration people; the students graduating from engineering colleges were with those from other colleges. Giving courses which are not fundamental is bound to displace fundamental courses.

(Later the question being raised as to whether a representative from Carnegie Tech. was present:)

The President of Carnegie Tech. asked me to consider the most practical way of utilizing a magnificent plant which had been erected for the purpose of teaching industrial engineering; it was not used for this purpose, industrial engineering having been unsuccessful at this school.

W. A. Knight: Industrial Engineers at Ohio State get mathematics, English, drawing, etc., the same as the mechanical engineers and electrical engineers. The criticism of Dean Disque from Drexel Institute does not apply to work at Ohio State. At Ohio State we believe first in making an engineer. Mechanical Engineering courses have been filled up until the backbone of them is steam engineering and machine design; this has been so for years. In all these years industries have been demanding more technical knowledge. Mechanical Engineering professors have neglected this opportunity of fitting men to take such places. Shopwork has been shoved back and it is the backbone of industrial engineering. Steam engineering and hydraulics, etc., have been left out of the industrial engineering curriculum. The quality of some of the work turned out in the industrial engineering laboratories by the students is astonishing. As far as Ohio State is concerned the question of whether the industrial engineering department should be degree granting or service, is closed.

H. W. Hastings: Approximately 55 per cent of our entire four-year course is given over to mathematics, physics, chemistry, etc., preparation for strictly engineering work and engineering work itself. Do not sacrifice on the engineering side of subjects. Until one year ago the General Electric Company would not interview our seniors because they did not have sufficient basic engineering training to take the testing course given by this Company to all prospective employees. Last year General Electric took two of our students to try them out. As a result the Company came back this year for all the men available from the Industrial Engineering De-

partment. The students now are not lacking in the basic engineering training. We seek to give much beyond mere mechanisms of management. We aim to give students a much broader view of management. We attempt to give them a picture of the extremely complicated situations in which one finds oneself in an executive position. We tell our students that if they ever expect to arrive at a position beyond mere routine work, a position of responsibility, they must have a broad background, much broader than they can get in college. Each year a course is conducted in which the students are introduced to some of the major functions of management: inter-relations of different agencies of government in this country, labor problems of organizations, human relations in dealing with each other, power of federal authorities with respect to mergers, power of local and state authorities in the regulation of factories, etc., to show them speculative problems which cannot be solved by application of the basic principles learned in college. Students taking only a mechanistic course do not remain open-minded in problems of human relations. We want our industrial engineers to be conscious of personnel problems.

We hope to point out to our students a course of study which, if followed for 15 years after graduation, will then place them in a position of major responsibility.

We feel that it is wholly desirable to have students take industrial engineering in a separate department. We have had close cooperation from other departments in our College. We feel that we can get a better product if students are registered in an industrial engineering department with the goal of a position of major executive responsibility in mind.

JOHN YOUNGER, The Ohio State University

First of all let me state that I believe there are distinct advantages in having the Industrial Engineering Shops and the Industrial Engineering Courses under one roof.

a. Students in industrial engineering must learn the coordination of mind and muscle, in order that they may form

judgments on men. Later on they will be managing men and will find their shop experience valuable. Theory should be closely related to shop practice and should be taught concurrently.

b. Time Study and Work Analysis is a necessary part of the training of the industrial engineer. It is impossible to place a number of students time studying in any one plant, and if they are placed in many plants they have no standard measuring stick to gage their efforts.

A policy is therefore indicated of having one's own shop with one group of students fabricating a definite engineering product and a more advanced group time studying them.

One interesting sidelight in this process is that although the time study men are studying students, they are able to gain a degree of judgment of the varying skills they meet with.

Another is that having themselves already completed the project they can pick up the idea of time study much faster.

c. Work Routing is another necessary study of the industrial engineer. In this work they are taught the proper sequence of machining operations and the method of laying out a shop.

It would be difficult, if not impossible, to place a large group of students in a manufacturing establishment or in several to learn the fundamentals of this work. It is necessary to know the project very thoroughly before such fundamentals can be clearly realized. Here again, therefore, we have an indication that the self-contained shop is desirable.

The students can get information as to the latest machinery by correspondence and then lay out two shops, one with which they are familiar, and one, the ideal shop. The contrast between the two as expressed in dollars and cents of factory costs drives home the economic value of the ideal shop.

Incidentally in this course considerable practical training can be given in accounting and in forming judgment of costs of machining operations.

d. A knowledge of jigs, fixtures, and tools is necessary.

Fundamentals can be acquired and if the shop is self-contained, projects with which the student is familiar can be studied from the standpoint of "tooling up." The student also has the necessary facilities for making his own fixture and trying it out personally.

The important points in the above discussion are that with one's own shop a project can be worked on by the students from the beginning of foundry or forge work, through the fabrication work right to the economics of manufacturing in its branches of time study or work routing.

Also the projects can be discussed in a tie-up between actual making and the economics of making in the various lecture courses. The examples given will be more or less understood by all students, thus saving much time in bringing out the fundamental points.

C. W. LYTLE, New York University

The objective in all undergraduate laboratory work is to supplement the classroom work with experimental or practice work which will illustrate the application of principles to actual materials and forces. By the very nature of things such work must be limited and therefore selective or representative only. For some courses the school laboratory or shop is certainly adequate but for others it is as certainly inadequate. The question of adequacy arises in chemical engineering, civil engineering, and aeronautical engineering as well as in industrial engineering. The degree of adequacy varies among these different fields and merely reaches its lowest effectiveness in the management field.

On the physical side we may illustrate this variation by comparing chemistry with chemical engineering. The primary difference between these two fields is the scale of application and the complexities which come with the larger scale of the latter. We can familiarize the student with chemical reactions in a school laboratory because typical reactions can be brought about in test tubes. We can not familiarize him with many of the principles of chemical engineering unless

we set up elaborate and widely diverse units of large scale processing. In civil engineering we can provide practice in surveying by using the campus or a camp site, but we can not do this well for the practice pertaining to bridges, dams or building construction. In aeronautical engineering we can test the behavior of aerofoil sections in a wind tunnel, but we can not go into the construction or the operation of whole airplanes. It needs no statistics to demonstrate the impracticability of financing school laboratories for these exceptions. Furthermore, it would be impossible for any school to keep up to date even if it started out on an adequate scale.

The same difficulties apply to the management field, first, because the student may elect any one of the other engineering fields for management, second, because management is a coordination of many factors and, third, because management is greatly influenced by the scale of operation. In addition, the school laboratory can not duplicate the human setting, the cost-competition influence nor the variety of emergencies. The school shop at best may have one real workman to a hundred students, while the outside shop will have one student to a hundred real workmen. The latter proportion is infinitely superior as a training environment for human relations. The school shop instructor can not reproduce the true position of the outside foreman, to say nothing of the whole outside organization. The acquaintance of many workmen, that is, of all types, is worth more than any make-believe paper work which a school shop may set up.

It has been claimed that such matters as cost may be better demonstrated in the school laboratory because the student in the outside shop rarely is allowed to see confidential figures. There is some truth in this, but it is offset by the failure of the school laboratory to represent overhead costs properly. We maintain that for management the school laboratory is bound to give the student an overemphasis on material and direct labor costs with underemphasis on overhead costs. Overhead control has come to be the greater problem.

Management is mere routine when there is no emergency, growth, or change in policy. The school shop may have these factors to a small extent, but the time usually given to school shop periods is too short and conditions too fixed to typify true development and expansion. The influence of market and style factors, new materials and new processes is necessary to provide a real management environment.

Ruling out thereafter graduation cadet courses in industry as too late to assist classroom work, there remain two solutions, summer work and cooperative work. Summer work may be quite satisfactory provided the school takes a supervisory control in which case it approaches the cooperative plan. Without school control it may vary from zero to one hundred per cent in effectiveness, depending on the student and his single resources. It is more often near zero than one hundred. Few undergraduates know what they need or how to get it. They invariably seek the highest wage or the most pleasurable job, such as camp councilor. Even if a student happens to secure a good opportunity he either fails to rotate, or seeks rotation by dabbling with too many different companies.

The cooperative work, broadly including the year out sometimes used, meets the above difficulties and undertakes to accomplish the following:

1. To eliminate the wrong field:
   (*a*) by discussion,
   (*b*) by trial and error.
2. To place the student where experience will be most suitable.
3. To coach him negatively and positively.
4. To assist him in making the most of each job.
5. To assist him in securing proper rotation and promotion.
6. To secure a professional attitude through bi-weekly report writing.
7. To support the student with departmental information.
8. To tie-in the classroom work with his various experiences.
9. To start him on a permanent career.

Some will say that this program does not give the equivalent of school laboratory work. It does not in all respects but it does in the very respects most difficult for the school alone. The school laboratory should be continued as in other courses. For instance, cost accounting, statistics and charting, jig and fixture design, plant layout, time and motion study or job standardization, etc., may all be given in school laboratories at least enough to teach technique and general practice. Even here the case material available in the cooperative reports is of assistance and trivial matters do not require as much time as they do in the instruction of all-resident students. Teachers who have taught both types of students prefer cooperative students on account of their better appreciation, better comprehension, better sense of practice and greater maturity age for age.

Discussion

O. M. Leland: (Dean Leland was called upon to explain the "mass" production of rowboat motors by the Industrial Engineering Department at Minnesota.)

I am not sure that one would call it "mass" production. We do accomplish this: the development of the interest of the students. Do not mistake these rowboat motors for the front end of a dredge model. The rowboat motor is five feet long and when hung on the edge of a rowboat pushes the boat ahead. These motors are made in machine shop by students taking fairly short courses in machine shop work. The motor has been developed to about its lowest terms because to be completed by students in such a short time as they have, it must be very simple. The motor is also developed to illustrate as many principles as possible in the different elementary processes. The idea of our machine shop work in this connection is that it will be a foundation of information with regard to those fundamental processes upon which the mechanical engineers, and to some extent the electrical engineers, but primarily the mechanical engineers, may get something to work on in their production and industrial engineer-

ing courses. Getting what we are driving at: the interest of the students in doing something with their own hands, that they can turn gasoline into and it goes. We sell these motors generally to the students themselves. Eventually a student becomes associated with one particular engine. The student can pay for the cost of the material and carry off the motor. We do get quite a thrill into these students by letting them make something that will run. The other students consider the making of these motors a real achievement.

I suppose there is involved in this general discussion the question of shopwork or no shopwork. Some schools have no shopwork; say they do not need it. Personally I was bred into civil engineering. I do not pretend to know much about mechanical engineering. I do feel very strongly for shopwork for all engineering students. We require freshmen shop for all engineering students; this includes courses in pattern making, foundry and forging; a one-year course, two credit hours a week. Every Dean has to justify this shopwork to his President because once in a while some other college President will tell your President that there is nothing to this shopwork, that it is a waste of material and a waste of effort. The justification for shopwork lies in two or three points:

First: Even in these days there are students that come to the engineering school that have never seen a plane, I won't say hammer; have never seen common tools. Students do not know anything about the language of a shop; they could not talk to a mechanic. Students do not know the difference between iron and steel; the difference between copper and brass. These are facts and these students are not fools; they know a lot about other things. Shopwork is a very desirable part of the equipment of an engineering school because the student learns the handling of tools, learns something of the nomenclature of shopwork; gains a knowledge of materials; teaches them that steel can be burnt, can be spoiled. Shopwork should be included in the curricula for civil engineers and mechanical engineers also.

L. H. Rittenhouse: There is not much conflict between these two questions. These advantages have been pointed out on each side: stimulating the interest of the student, giving him an appreciation of costs, teaching him to think. This last is the most important. We do not recognize such a term as industrial engineering at Haverford. We do require 40 or 50 hours in a specific shop course for freshmen. Students get pepped up about making a screw jack. After completion it is compared with a jack bought on the market. We do not have to ask a question. The student's jack costs about $7.50 to make; the jack bought on the market is priced at $4.50. This leads to a shop conference on what is to be done about this difference in cost. We find that this makes for stimulation of interest, and that it is a good educational principle.

A. L. Williston: Another point of view may be interesting in this discussion. The Carnegie Foundation recently brought to this country a professor from England. He has been going about the United States giving a series of lectures. This philosopher has found evidence of a growing new religion: the passion for excellence. It challenges the skill of the artist. Passion for excellence in personal performance is outstanding in engineering. This is the fundamental reason for shop practice, cooperative or non-cooperative. Shopwork is the best instrument ever produced for inculcating in the individual this passion for excellence. Unfortunately shops in the universities have not been manned by the highest priced men on the campus, and in such places this passion for excellence has not developed.

Experience comparing shops: at Pratt Institute the shop instructors are among the highest paid men at the Institute. The cost of instruction per student-hour was less than one-half the cost of instruction by and large in engineering schools of A grade throughout the country. It is not necessary for shops that are organized like the best industrial shops in the country, to have shops anywhere near as expensive as most of the other instruction in engineering schools.

In shopwork the student is the first one to be dissatisfied with his lack of accuracy; it is not only the instructor.

J. D. Hoffman: I shall not speak of school shops. I shall add one point regarding the reasons why some universities are on the school shop proposition. It is an expensive type of education; it is not out of the way to admit this. I have been in that line of work all my life. The question is the advisability of continuing shop courses and increasing them, not reducing them. Shopwork is one of those things in a college course wherein a young man is taught accuracy. What is more accurate than a mechanical measurement in a machine shop, or heat treatment of a piece of steel to find the critical temperature on which to treat it? Shopwork teaches accuracy, one of the finest things a young man can learn. To become personal, I was one of those who worked my way through college; I served an apprenticeship in a shop and on taking the theoretical work found that I got along much better than those who had had no practical work in the same line. Practical work in the shop is one of the greatest assets along with the college course. The cost of instruction per student hour is less in shops. The extra cost is where shop courses are in the first and second years when there are large loads to handle and a large amount of machine room space is required.

H. W. Hastings: For our industrial engineering course we have no shop work in the undergraduate course for any engineers. We do not feel that it is worth while to spend that much time on it, or rather, that the time can be spent to better advantage on other things. In the month preceding the opening of the junior year, the students take a course called Mechanical Technology, for want of a better name. This course lasts one month: the mornings are given over to lectures on shop equipment and processes; afternoons to visiting shops. Reports are required to be written on these visits. For actual experience in doing shop work, which certainly should be required, students are directed in summer work. We are not so well organized in this as they are

at New York University. The men are sent out on their own; it is a wholesome experience in the difficulty of meeting the standards of industry and in acquiring skill, subject to dismissal if work is not satisfactory. We hope that the students, after graduation, will be placed on the bench to begin with. As far as inculcating accuracy, this can be developed very well in mechanical engineering and electrical engineering and in the summer survey course between the freshman and sophomore year. The time used for shopwork can be used to better advantage during the school year.

John Younger: If I had my way about it every student in every college would take shopwork as a means of giving them some culture. Today a knowledge of handmade things is absolutely essential. Everything we handle in this world is made some time, sooner or later and every student should have some knowledge of how things are made. In addition to shop work here students are also given compulsory outside work during the summer; there are 10 hours credit for this. The students are sent out to work after being instructed in what to do and what to see in going into the outside shops. In addition, there is a new idea about inspection trips. Three-hour inspection trips are a thing of the past. Last quarter we spent three days in the Timken Roller Bearing plant, three days in the Goodyear plant. The sad part about it is that the inspection trips last only one week. Another thing: we think of shop courses as teaching men to do things but it teaches men how to think about things. They have opportunity while working to think about what they are doing.

C. W. Lytle: As the one responsible for this four-cornered program, I would like to attempt a brief summary. On the first issue we are plainly at variance. The experiences appear to be quite contrary and equally positive. Both the degree granting department and the service department methods are accomplishing good results. The necessity for both may indicate some difference in purpose but in the main I think it means a difference in local conditions.

On the second issue the disagreement is less than might have

been expected. We who emphasize the outside shop recognize the place of the school laboratory for certain phases of industrial engineering projects but we do not concede the claims cited by Professor Younger under the designations of a, b, c, and d, as true advantages for the school shop. Those who emphasize the school shop recognize the desirability of outside summer work. Perhaps each side is erring in its emphasis and would do well to make more of the unemphasized feature. If that were done there would remain little essential difference. I wonder if we do not go along too contentedly on our own experiences without knowing at first hand what the other experiences really are. May I suggest more and longer inspection trips for teachers of Industrial Engineering to other campuses than their own.

DIVISION OF COOPERATIVE ENGINEERING EDUCATION

Believing that the continued growth in the number of engineering colleges offering cooperative courses is evidence of a live interest in this educational method, the undersigned petition the Officers and the Council of the Society for the Promotion of Engineering Education for permission to form a Division of Cooperative Engineering Education. It is the hope of the petitioners that arrangements can be made to hold the first meeting of this Division at next summer's convention at Montreal.

Respectfully submitted,

K. G. MATHESON,
FRED E. AYER,
DUGALD C. JACKSON, JR.,
J. E. MCDANIEL,
E. WILLIS WHITED,
CHAS. W. LYTLE.

Council, by letter ballot, has approved this petition.

NEW MEMBERS

DREESE, ERWIN E., Professor (Chairman) of Electrical Engineering, The Ohio State University, Columbus, O. F. C. Caldwell, E. A. Hitchcock.

FRASER, ISAAC M., Professor of Mechanical Engineering, University of Saskatchewan, Saskatoon, Sask. C. J. McKenzie, A. A. Potter.

HEANY, ARTHUR G., Sales Promotional Department, D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York City. C. L. Swensen, S. J. Boller.

KAHN, LOUIS, Instructor in Electrical Engineering, Rutgers University, New Brunswick, N. J. F. H. Pumphrey, H. D. Hatfield.

MILLER, CURTIS A., Sales Promotional Department, D. Van Nostrand Co., Inc., New York City, C. L. Swensen, S. J. Boller.

POOLE, FRED L., Associate Professor of Electrical Engineering, State Agricultural College, Fort Collins, Colo. H. G. Jordan, S. D. Crain.

REED, JOHN C., Instructor, University of Illinois, Urbana, Ill. Wm. T. Magruder, H. H. Jordan.

TROTTER, RICHARD A., Instructor in Steam and Gas Engineering, University of Wisconsin, Madison, Wis. G. L. Larson, D. W. Nelson.

TURNER, HUBERT M., Associate Professor, Yale University, New Haven, Conn. R. I. Rees, O. W. Eshbach.

TYLER, RICHARD G., Dean, College of Engineering, University of Washington, Seattle, Wash. E. R. Wilcox, F. B. Farquaharson.

WILSON, DAVID M., Assistant Professor of Civil Engineering, University of Southern California, Los Angeles, Calif. P. S. Biegler, G. H. Dunstan.

AMERICAN ENGINEERING COUNCIL

The American Engineering Council announces the appointment of three engineering advisers to aid in the work of organizing the Industrial Museum founded in Chicago by Julius Rosenwald. They are:

M. E. Cooley, Dean Emeritus of the Colleges of Engineering and Architecture, University of Michigan; E. L. Ryerson, Joseph T. Ryerson and Son, Chicago; Joseph W. Roe, Professor of Industrial Engineering, New York University.

PRESENT TRENDS IN MEDICAL EDUCATION *

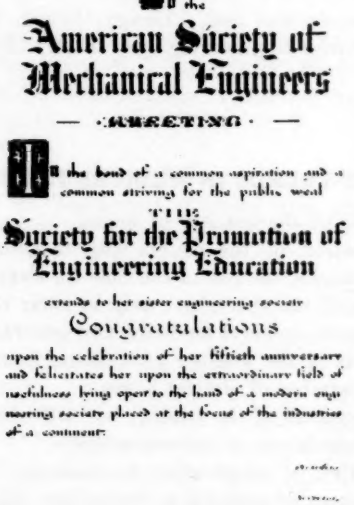
1. Reduction of the number of hours.
2. Liberalization of the course (by teaching only basic courses and utilizing the rest of the time for electives).
3. Teaching of the specialties only in their relation to the two main courses—general medicine and general surgery.
4. Reduction in the number of didactic hours and an increase in the number of clinical hours.
5. Encouragement of the student to "self-education."
6. Better correlation of various subjects.
7. Elimination of duplication in teaching.
8. Development of teaching in outpatient department.
9. Elimination of long summer vacations.
10. Substitution of a few comprehensive examinations for many departmental examinations.

F. H. KRUSEN.

* This is reprinted, for comparative purposes, from the March, 1930, *Journal of the Association of American Medical Colleges.*

GREETING TO A. S. M. E.

The following illuminated and engrossed greeting was extended by this Society to the American Society of Mechanical Engineers on April 5, 1930, at the celebration of its fiftieth anniversary.


To the
American Society of
Mechanical Engineers
— GREETING —
In the bond of a common aspiration and a common striving for the public weal
THE
Society for the Promotion of
Engineering Education
extends to her sister engineering society
Congratulations
upon the celebration of her fiftieth anniversary and felicitates her upon the extraordinary field of usefulness lying open to the hand of a modern engineering society placed at the focus of the industries of a continent.

COLLEGE NOTES

Massachusetts Institute of Technology.—Under the Department of Civil Engineering, Professor Glennon Gilboy and his associates are developing the study of Soil Mechanics, continuing the work of Professor Charles Terzaghi. Apparatus has been built, much of which is of unique design, and was invented here largely by Professor Terzaghi. A close relation is being brought about between Soil Mechanics and Structural Geology and Hydrology under Professor Frederick K. Morris. Especially the studies of soil-formation, of the field relations of the various types of soil, and of groundwater movements are of interest to the student of soil mechanics. Not less is the geologist indebted to the student of soil mechanics for the accurate studies of load and yield of soils. The increasing cooperation of the two departments will have a favorable influence for both.

The department of Military Science assigns an important value to the influence which topographic-geologic structures bear upon military strategy. Accordingly Major Eddy has requested Professor Morris to give two lectures on the geology and topography of the Western Front and on a geologist's analysis of a particular campaign.

Under the Department of Mining, Mr. F. L. Foster is developing the important study of geophysical exploration. The magnetometer, the torsion-balance and the various electrical methods are used. Seismic methods have not been added, but this development is confidently looked for in the future. The purpose of the study is essentially to extend our knowledge of the structure of soil and rock; and the logical development leads toward a close liaison with structural and economic geology. Accordingly Professor F. K. Morris is cooperating with Mr. Foster in field-work and in the interpretation of results.

Facilities for study and research in crystallography are

being extended in the Department of Geology. In keeping with the growing realization that crystallography is the scientific background of applied metallography, a course of instruction in physical crystallography is now offered to metallography students by Prof. Martin Buerger.

For those preparing for stratigraphic work in oil regions cooperation with The Cushman Foraminiferal Laboratory at Sharon has been brought about by Professor Hervey W. Shimer, and has proved most helpful.

BOOK REVIEW

General Metal Work. By ALFRED B. GRAYSHON. Van Nostrand. 206 pages. Price, $1.70.

This book is based on the course given by the author at Jay Cooke Junior High School at Philadelphia. The title is somewhat misleading as it covers chiefly work in sheet metal, strap iron and bar stock, and leaves out the great field of forging, welding, general machine work, etc.

Within its limited scope the book seems very well planned for the purpose in view. A large number of projects are carefully laid out for making small tools, household articles, etc., from sheet and bar stock. Such a course should stimulate the interest of boys of the grade for which it is designed, and should develop a considerable degree of manual skill as well as the ability to design and plan the making of small articles of handicraft.

J. A. D.